

Definition and Identification of Polyethylene

Polyethylene is polymerized ethylene. It is characterized as a medium soft, very feeling, colored, translucent plastic. It has rather low physical strength properties, chemical inertness and is generally an excellent electrical insulating material. It is the only low cost, easily processable dielectric used for radar, electronic and communications equipment cable.

The dielectric grades having excellent dielectric properties as shown in the table below are the important polyethylenes. Grades 4 and 5 having very low dissipation factors and low dielectric constants make them exceptionally good for electronic equipment insulating materials. They are considered high molecular weight polyethylenes. Grade 6 is a dielectric grade also, but is used as an outer jacket, usually at commercial power frequencies.

The American Society for Testing Materials, Tentative Specification for Polyethylene Molding and Extrusion Materials, ASTM, D1248-67T, issued in 1962 defines two basic types and contains applicable test methods. Type I, having grades 1, 2, and 3 thereunder, and Type II, having grades 4, 5, and 6 thereunder, defines the properties of polyethylene with which we are concerned.

Type I is defined as follows: "A group of general-purpose compounds for molding or extrusion, consisting of an unmodified form of polyethylene, with or without the addition of colorants, as may be specified, each representative of a different melt index range."

Type II is defined as follows: "A group of dielectric compounds for extrusion consisting of polyethylene resin containing a suitable antioxidant. Three grades are specified, each of which is representative of dielectric quality."

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TYPE I

TYPE II

	General Purpose Material				Ballistics Material			
	Natural and Colors				Natural Colors General Purpose			
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 1	Grade 2	Grade 3	Grade 4
Specific Gravity 20/20°C	0.91 to 0.93	0.91 to 0.93	0.91 to 0.93	0.91 to 0.93	0.91 to 0.93	0.91 to 0.93	0.91 to 0.93	0.91 to 0.94
Moist Index & Resistance	1.3 to 1.8	1.3 to 2.7	0.8 to 1.6	0.8 to 2.3	0.8 to 2.3	0.8 to 2.3	0.8 to 2.3	0.8 to 2.3
Penetration Strength	1200	1400	1400	1400	1400	1400	1400	1400
Ultimate Elongation	400	400	400	400	400	400	400	400
Ballistic Temp. Min. Temp. max.	—	—	—	—	-40	-50	-50	-50
Disintegration Factor at 50 to 110 in per sec.	—	—	—	—	0.0005	0.0025	—	—
Disintegration Constant at 50 to 110 in per sec.	—	—	—	—	2.35	2.50	—	—

EXTRACTED FROM ASTM-D1228-52

The dielectric grades, 4, 5, and 6 are the important grades. They are characterized by high molecular weight, contain suitable chemical anti-oxidants which do not affect dielectric properties and permit the material to withstand the rigors of aging and weather without deterioration or change in dielectric properties. The exception to this is grade 6 which is pigmented black to give ultimate in outdoor weather resistance. This pigmentation with black dyes or carbon affects the dissipation factor. The black grade, as a consequence is usually used as an outer jacket over the grades 4 and 5.

Types I, grades 1, 2 and 3 are essentially the "apex bottle grades" and are used for consumer goods. They may be pigmented almost any color and are mostly low molecular weight polyethylenes. It follows then, that the important and strategic polyethylene is characterized by high molecular weight, very low dissipation factor, low dielectric constant and is stabilized with suitable anti-oxidants. To positively identify the two important grades 4 and 5 of type IX will require laboratory tests for salt viscosity index, dissipation factor and dielectric strength. There appears to be no other satisfactory or acceptable means of accomplishing this.

A further complicating factor presents itself in that high molecular weight polyethylene and/or dielectric grades such as 4 and 5 could be used for apex bottles and/or consumer goods as well as the low molecular weight polyethylenes such as grades 1, 2 and 3 of Type I. This is not a practical situation but one that could arise without positive means of identifying the particular quality or grade of polyethylene. It is also very impractical that the low molecular weight polyethylenes such as grades 1, 2 or 3 would be used as dielectric grades because of special compounding, formulation and quality control that would be required to make them dielectric grades. Actually, a polyethylene having the molecular weight and physical properties of grade 1, is the only candidate material for possible dielectric use. It must be "cleaned" up electrically if it would be used as a dielectric. It is believed, that with a possible exception, the "apex bottle" polyethylene, grades 1, 2 and 3 of Type I will not be used as dielectrics.

Manufacturers' specifications and data sheets may require properties and contain data over and beyond that contained in the ASTM specification; it is believed that they will always contain what the data specified in ASTM D 1248-55T.

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~~It was suggested that ASTM test a certain procedure to accept the~~
 dielectric grade polyethylene. A system of certification and/or affidavits *could*
 be utilized to label or identify the polyethylene as dielectric grade.
 The enforcement of the certification system *could* be backed up with Government
 prerogative to conduct tests if deemed necessary to establish identity
 within a specified time limit.

This matter could be further explored with industry advisory groups to obtain their reaction should this appear desirable.